

I claim:

1. A nozzle type device with an integral pump, where the nozzle type device is adapted to atomize liquids at a nozzle tip surface by capillary waves generated in a liquid layer thereon by application of a frequency above about 200 kHz in transducers
5 attached distal to the nozzle tip comprising:

(a) two or more horn stages, each having a central channel defined within a body of the horn stage extending from a base and a horn tip, each horn stage being further adapted to have a length of about one half of the acoustic wavelength at the frequency;

(b) a driver section of about one half of the acoustic wavelength at the frequency with
10 the transducers rigidly attached therein and having a central channel defined within a body of the driver stage extending from a forward end to a rearward end;

(c) a forward horn stage section comprising one or more sequentially connected forward horn stages, with a first base of a first forward horn stage integral with the forward end; and

(d) a pump horn stage section comprising one or more sequentially connected pump
15 horn stages, with a first base of a first pump horn stage integral with the rearward end;

(e) the central channels of all the horn stages and the driver section form a continuous channel extending from an inlet opening defined in a free end of the pump
20 horn stage section to an outlet opening defined in a free end of the forward horn stage section.

2. The device of claim 1 wherein the horn stages are Fourier horns.

3. The device of claim 1 wherein the forward horn stage section comprises at least
25 three horn stages.

4. The device of claim 1 wherein the pump horn stage section comprises at least two horn stages.

30 5. The device of claim 1 wherein a cross section shape of the horn stages is conical.

6. The device of claim 1 wherein a cross section shape of the horn stages is rectangular.

5 7. The device of claim 6 wherein the horn stages are comprised of two planar halves formed by silicon wafer manufacturing and joined to define the central channel.

8. The device of claim 1 wherein a cross section shape of the central channel is oval, square, rectangular, diamond, or circular.

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9. The device of claim 1 wherein the horn stages comprise substantially only silicon, silica compounds or silica composites.

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